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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:

Ko et al. 09/585,682

Serial No.: ~~09/795,999~~

Filed: June 1, 2000

For: SEMICONDUCTOR DEVICE HAVING A SUBSTRATE, AN UNDOPED SILICON OXIDE STRUCTURE, AND AN OVERLYING DOPED SILICON OXIDE STRUCTURE WITH A SIDE WALL TERMINATING AT THE UNDOPED SILICON OXIDE STRUCTURE

Examiner: C. Chu

Group Art Unit: 2815

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BRIEF ON APPEAL

Assistant Commissioner for Patents
Washington, D.C. 20231

Attn: Board of Patent Appeals and Interferences

Sirs:

This brief is submitted in triplicate and in the format of 37 C.F.R. § 1.192(c). A check in the amount of $310.00 for the fee under 37 C.F.R § 1.17(c) for filing a brief in support of an appeal is enclosed.

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(1) REAL PARTY IN INTEREST

The real party in interest in the present pending appeal is Micron Technology, Inc., assignee of the pending application as recorded with the United States Patent and Trademark Office on June 22, 1998, Reel 9273, Frame 0990.

(2) RELATED APPEALS AND INTERFERENCES

Applicant reports that two related applications are currently on pending appeal before the Board of Patent Appeals and Interferences. The first appeal is serial number 09/625,144, filed July 25, 2000, and the second appeal is serial number 09/711,324, filed November 13, 2000.

(3) STATUS OF THE CLAIMS

Claims 1 through 13 are pending in the application.

Claims 1 through 13 stand rejected.

Claims 1 through 13 are the subject of the present pending appeal.

(4) STATUS OF AMENDMENTS

A first Office Action in the above-referenced application was mailed by the Office on August 6, 2001. Each of claims 1 through 13 were rejected in the first Office Action.

On October 30, 2001, an Amendment was filed in response to the first Office Action. In that Amendment, independent claim 6 and claims 10 and 13 were amended.

A Final Office Action was mailed by the Office on February 15, 2002. Claims 1 through 13 were again rejected.

A response to the Final Office Action was filed on April 12, 2002. No claim amendments were presented in that response.

An Advisory Action, which was mailed by the Office on May 3, 2002, indicated that the rejections of claims 1 through 13 had been maintained.

(5) SUMMARY OF THE INVENTION

The invention relates to dry etch processes for selectively etching doped silicon dioxide that overlies silicon nitride or undoped silicon dioxide. Specifically, the etchants that may be used to effect the method are selective for doped silicon dioxide over both undoped silicon dioxide and silicon nitride. (Specification, page 8, lines 24 and 25). Doped silicon dioxide typically includes a dopant such as boron or phosphorus, whereas undoped silicon dioxide is substantially free of dopants and other impurities. Examples of doped silicon dioxide include, but are not limited to, borosilicate glass (BSG), phosphosilicate glass (PSG) and borophosphosilicate glass (BPSG). (Specification, page 8, lines 28 and 29).

The selective etchant includes an ethane component having the general formula $C_2H_xF_y$, where x is an integer from two to five, inclusive, y is an integer from one to four, inclusive, and x plus y equals 6. (Specification, page 9, lines 3 - 7). As the $C_2H_xF_y$ component of a doped silicon dioxide etchant is RF activated, the hyrdrogen ions and activated hydrogen species react with the fluorine-containing ions and activated fluorine-containing species (e.g., F* and CF*), removing

the activated fluorine-containing species from the surface of the wafer prior to the occurrence of any substantial amount of etching of an etch stop layer of either undoped silicon dioxide or silicon nitride. (Specification, page 9, lines 11 - 16).

Where $C_2H_xF_y$ is utilized as a primary etchant, fluorocarbon and other halogenated carbon materials which have been used as primary etchants in conventional doped silicon dioxide dry etch techniques are added because $C_2H_xF_y$ etches doped silicon dioxide at relatively slow rate compared with the etch rates of conventional silicon dioxide etchants. (Specification, page 9, lines 23 - 27). Alternatively, $C_2H_xF_y$ may be employed as an additive to one or more fluorocarbon primary etchants which etch silicon dioxide at a higher rate than they etch silicon nitride. When $C_2H_xF_y$ is used as an additive, $C_2H_xF_y$ imparts the etchant mixture with selectivity for doped silicon dioxide over undoped silicon dioxide, while permitting the doped silicon dioxide etch to proceed at a comparable rate relative to many conventional doped silicon dioxide dry etch techniques. (Specification, page 10, lines 12 - 16). In addition, the amounts of other etchants may be varied in order to more specifically tailor the selectivity of an etchant combination for doped silicon dioxide over undoped silicon dioxide, and for doped silicon dioxide over silicon nitride, as well as to control the rate at which doped silicon dioxide etched. (Specification, page 10, lines 19 - 28).

The dry etch process of the present invention may be effectively employed for anisotropically etching a doped silicon dioxide layer down to an underlying etch stop comprising either undoped silicon dioxide or silicon nitride. A mask layer is patterned over the doped silicon dioxide layer. (Specification, page 12, lines 13 and 14). The inventive etchant is

introduced to attack the open areas not covered by the photomask. (Specification, page 13, lines 10 - 12). The anisotropic dry etching processes available for use with the present invention include, without limitation, high density plasma etching, reactive ion etching, magnetic ion etching, magnetically enhanced reactive ion etching, plasma etching, point plasma etching, plasma enhanced reactive ion etching, and electron cyclotron resonance. (Specification, page 13, lines 12 - 18).

The etchant and selective, anisotropic etching process may be used to form at least one sidewall from a layer of passivation material, such as doped silicon dioxide, that is oriented substantially vertical to a plane of a substrate over which the layer of passivation material is located and that at least partially terminates at an undoped silicon dioxide structure. (Specification, page 12, line 26, to page 13, line 5; FIG. 4). An example of such a structure may comprise a contact opening to an active device region located adjacent to at least one transistor gate. *Id.* The side walls of the contact opening may be oriented substantially perpendicular to a plane of the underlying semiconductor substrate and include portions that terminate at an undoped silicon dioxide cap of the at least one transistor gate structure. *Id.*

(6) ISSUE

Whether claims 1 through 13 are allowable by United States Patent 5,275,972 Ogawa et al. (hereinafter "the Ogawa patent") under 35 U.S.C. §102(b)?

(7) GROUPING OF CLAIMS

Claims 1 through 13 should be grouped together. Independent claim 6 is representative of the claims in this group. Claims 1 through 13 stand together, but do not fall together. Claims 1 through 5 stand and fall together, while claims 6 through 13 stand and fall together.

(8) ARGUMENT

ANTICIPATION 35 U.S.C. §102(b)

The Advisory Action of May 5, 2002, provides that the arguments that were presented in the response to the Final Office Action were not persuasive and, therefore, did not overcome the anticipation rejection under 35 U.S.C. §102(b). To establish and maintain a rejection of a claim based on 35 U.S.C. §102(b) anticipation, "each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Moreover, the identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

In view of the arguments set forth below, it is respectfully submitted that the requirements of 35 U.S.C. §102(b) have not been met.

It has been asserted that the language "substantially perpendicular," recited in independent claims 1 and 6 to describe at least one sidewall of the doped silicon oxide structure of the present application, is a "broad term," and the curved sidewall of FIG. 1C of the Ogawa

patent "reads on substantially perpendicular" sidewall of the present application. (Advisory Action, page 2).

The Ogawa patent describes an intermediate semiconductor device structure, illustrated in FIG. 1C thereof, as including a semiconductor substrate 2 with active device regions 6 formed therein. Conductive lines 4 are disposed upon substrate 2 and flanked by sidewall spacers 5. An undoped silicon dioxide cap 8 is disposed over and in contact with each conductive line 4. In addition, the intermediate semiconductor device structure shown in FIG. 1C of Ogawa includes a silicon dioxide film 9, as well as a silicon nitride film 10 thereover, which together act as an etch stop layer. (Ogawa, Col. 8, lines 53 - 56). A passivation layer 11, which is formed from BPSG, overlies silicon nitride film 10. As depicted in FIG. 1C, a contact aperture (unnumbered) is defined through passivation layer 11. Ogawa employs a dry *isotropic* etching process to form the contact aperture through passivation layer 11. (Ogawa, col. 8, line 67, to col. 9, line 3, and as depicted in FIG. 1C). The result is that the sidewalls of the contact aperture defined through passivation layer 11 are not oriented substantially perpendicularly to a plane of semiconductor substrate 2. In fact, the sidewalls are curved in appearance and undercut the photomask 3 that overlies passivation layer 11. The reasons for this are that dry isotropic etching is an etching process that etches in a plurality of directions and, therefore, produces curved sidewalls that undercut mask features. The dry isotropic etching process is accomplished with a reactive species in the gas phase (e.g., SF_6 as disclosed in Ogawa, col. 9, lines 25 - 29), which reacts with the passivation layer 11, creating gaseous reaction products, which are removed. The process is chemical in nature and the result is that the etchant material reacts with the passivation layer 11

sidewalls in all directions at the same rate. Therefore, when formation of the contact aperture is completed, the radius of curvature of the curved sidewall equals the thickness of the passivation layer 11, which produces an undercut distance of the photomask 3 that is about the same as the thickness of passivation layer 11.

In contrast to the structure described in the Ogawa patent, independent claim 1 recites "a passivation layer over said undoped silicon dioxide cap," and "at least one contact aperture defined through said passivation layer and including at least one sidewall extending substantially perpendicularly relative to said semiconductor substrate." Independent claim 6 recites "at least one doped silicon oxide structure over said at least one undoped silicon oxide structure and having at least one sidewall substantially perpendicular to a plane of said semiconductor substrate." The term "perpendicular", used to describe this geometric configuration in both independent claims 1 and 6, is defined as a line or a plane that is at right angles to another line or plane, something that is exactly vertical or upright, or being at right angles to a given line or plane. (Webster's Third New International Dictionary, unabridged, Merriam-Webster, Inc., Springfield, Massachusetts, USA, 1986). Hence the term "substantially perpendicular" used to describe the sidewalls of the aperture in claim 1 is a correct characterization of the orientation of a planar sidewall with respect to a plane of the substrate over which the passivation layer and undoped silicon dioxide cap are located.

Since the sidewalls of the passivation layer 11, described in the Ogawa patent are curved and not planar, the Ogawa patent does not expressly or inherently describe that the side walls are "substantially perpendicular".

It has also been asserted that the language "at least a portion of said at least one sidewall terminating at said undoped silicon dioxide cap" recited in independent claim 1 and, presumably, that similar language of claim 6 do "not specifically claim that the sidewall terminates directly on the surface of the undoped silicon dioxide cap [or structure]" (Advisory Action, page 2) and, thus, that the Ogawa patent describes this element of independent claims 1 and 6.

Referring to the Ogawa patent, following the sidewall from the top of the contact aperture defined through passivation layer 11, shown in FIG. 1C, to its point of termination, *the sidewall terminates at the silicon nitride layer 10* and does not continue on to the silicon dioxide layer 9, which lies below the silicon nitride layer 10. Moreover, Ogawa states that "isotropic dry etching was performed to etch the portion of the BPSG film 11 exposed through the opening in the resist 3 [i.e., photomask], thereby exposing the surface of the underlying silicon nitride film 10." (Ogawa, col. 8, lines 67 and 68; col. 9, lines 1 - 3). In other words, the Ogawa patent describes the use of a silicon nitride layer 10 as a position between the passivation layer 11 and the silicon dioxide layer 9, where the sidewall of the passivation layer 11 stops and does not reach the undoped silicon dioxide layer 9 underneath. Hence, Ogawa discloses sidewalls of passivation layer 11 that do not "terminate directly on" or "terminate at" the surface of the undoped silicon dioxide layer 9.

By contrast, independent claims 1 and 6 both recite that at least a portion of the sidewall of the passivation layer "terminates at" the surface of the undoped silicon dioxide structure. Specifically, independent claim 1 of the present invention recites "a passivation layer over said undoped silicon dioxide cap" and further recites "at least one contact aperture . . . through said

passivation layer and including at least one sidewall . . . a portion of said at least one sidewall terminating at said undoped silicon dioxide cap." (Emphasis supplied). Furthermore, independent claim 6 of the present invention recites "at least a portion of said at least one sidewall terminating at said at least one undoped silicon dioxide structure." (Emphasis supplied).

The word "at", as used in claims 1 and 6, is a function word used to indicate a position on a specified feature. (Webster's Third New International Dictionary, unabridged, Merriam-Webster, Inc., Springfield, Massachusetts, USA, 1986). Therefore, the assertion that independent claims 1 and 6 do not recite that at least a portion of a sidewall terminates directly on the surface of an undoped silicon dioxide structure is incorrect. Stated another way, in both independent claim 1 and independent claim 6, the passivation layer has a sidewall, at least a portion of which terminates directly on an undoped silicon dioxide structure, not on a silicon nitride structure, as described in the Ogawa patent.

Also, as the description of the Ogawa patent is limited to a passivation layer with an aperture therethrough which includes at least one sidewall, a portion of which terminates at silicon nitride cap, or silicon nitride structure, it is respectfully submitted that the Ogawa patent does not anticipate each and every element of independent claims 1 and 6.

It is, therefore, respectfully submitted that, under 35 U.S.C. §102(b), independent claims 1 and 6 are allowable over Ogawa.

Each of claims 2 through 5 and 7 through 13 are further allowable, among other reasons, as depending from independent claims 1 and 6, respectively, which are allowable.

In view of the foregoing, it is respectfully requested that the 35 U.S.C. § 102(b) rejections of claims 1 through 13 be withdrawn.

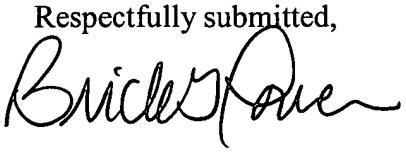
(9) APPENDIX

A copy of claims 1 through 13 is appended hereto as "Appendix A."

CONCLUSION

It is respectfully submitted that claims 1 through 13 are allowable and respectfully request that the rejections under 35 U.S.C. §102(b), anticipation, be withdrawn.

Respectfully submitted,



Brick G. Power
Registration No. 38,581
Attorney for Applicant
TRASKBRITT, PC
P. O. Box 2550
Salt Lake City, Utah 84110-2550
Telephone: (801) 532-1922

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